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HISTORY OF THE EVOLUTIONARY PROCESSES THAT LED TO THE DISCOVERY OF THE CIRCULATION OF THE BLOOD BY WILLIAM HARVEY.

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ONE of the most eventful, progressive and critical periods in the history of medicine occurred in the early part of the sixteenth century, when Pierre Brissot, an original thinker and keen observer, concluding that the time-honored practice followed throughout Europe, and taught at all of the schools and universities, regarding the proper locality chosen for bleeding, and generally known as the Arabian method of venesection, was an erroneous practice, undertook single-handed, and in the teeth of all European medical authorities, to overthrow that which he firmly believed to be wrong. The struggle led to the most momentous results, as it was the initial movement that, in the end, gave us Harvey's great discovery, and which subsequently led to the practice of transfusion of blood, which, later on, formed the foundation of our present knowledge of hematic studies. The struggle, initiated by Brissot in Paris, was carried on for over a century, and no history, whether of any of the struggles described by either Homer or Plutarch, or by a Schiller or a Prescott, can be more fraught with episodes full of romance, heroism, or furnish greater examples of human persistency and bravery, than contained in the details of that long war that surged in the domain of medicine, and which is known in medical literature as the bloodletting controversy of the sixteenth century, a controversy at first carried on by one single man against all, but which, through conversions, gradually assembled small isolated groups

of combatants to fight against each other, and finally ended by arraying in the opposing ranks and in the general fray universities and whole medical faculties, some of which did not scruple to invoke on their respective side the aid and authority of the royal powers, as well as the silent and sinister, but no less effective, influence of the dreaded Inquisition, which was then at the zenith of its power. In the struggle that followed, anatomist battled against anatomist, and physiologist against physiologist, each in accordance with his theoretic views of the subject, and as determined by his investigation. Discovery after discovery followed the impetus thus given to anatomy by the burning enthusiasm the controversy had kindled, and the desire for supremacy engendered by the fray, a fray from which medicine emerged greatly the gainer, and but for which it might have slumbered in self-satisfied sleep it then enjoyed for some centuries to come.

The Arabian method of bleeding was not instituted by the Arabians, as its name would denote, but by a Greek physician named Oribasius, who had been banished from the Roman empire, and who, like the banished Nestorians, had found a home among the Arabians, who then extended a hearty welcome to all scientists and philosophers. Oribasius, like Galen, was a native of Pergamos, where he first saw the light in the fourth century, although he is claimed by Suidas as a native of Sardis. Eunapius, himself a physician of great note, and a native of Sardis, and a great admirer of Oribasius, does not claim him as a fellow-native, which leaves his nativity to Greece; had it been otherwise, he would have claimed him for Sardis, as, in his opinion (and being one of the ablest physicians of his period, he was in position to judge) Oribasius was one of the ablest exponents of the science of medicine of his time. In his earlier life he had studied in the Cyprian school of Zeno, and so rapid was his progress that he soon acquired a great reputation, something which drew to him the attention of Julian the Apostate, who made him his medical attendant. In that capacity, he followed Julian to Gaul, and through his influence and ability was able to repay Julian's friendship by assisting the latter to mount the

imperial throne. Oribasius filled many high positions under his protector, among which was the post of Questor in Constantinople. He followed the emperor in his expedition against Sapor, King of Persia, where the emperor met his death from a wound of the liver.

After the death of his friend and benefactor, Oribasius fell into neglect at the hand of Valentinian and Valens, and at the instigation of his enemies, who had envied him his position and power under Julian, he was finally despoiled of his possessions and banished from the empire in the reign of Valentinian II. On his arrival among the Arabians he was well received, and it was not long before the brilliancy of his genius and his newly acquired reputation among these rising people became so great that the emperor hastened to recall him from his exile and restored him to position and wealth. Following the teachings of the period he employed revulsive bleeding in many diseases, being particularly favorable to the use of scarifications. During an epidemic of the plague in Asia, he was himself attacked, and attributed his recovery to the heroic bleedings which he caused to be made from his legs, losing as much as a quart of blood at one bleeding. Oribasius, probably led to the method through his practice in scarifying, adopted the system of bleeding from the legs and feet in general diseases, something that had not been done before his day. The practice was arbitrarily taken up by the Arabian physicians, who created for it a theoretic basis never dreamed of by Oribasius, and later on, when it was through the Arabians and the Jews that medical practice reentered Europe, the so-called Arabian method of bleeding from parts distant from the seat of the disease, in accordance with their newly formed theories, became the practice, the Galenic or Hippocratic practice of bleeding from the arms having, in common with the rest of Greek medicine, in the meantime sunk into oblivion.

From the fact that medicine had been treasured for some centuries only by the Arabians, who had in those long periods been its sole depositories, the new European schools of medicine were established on their system and the Arabian authorities alone were

cited or lectured upon and alone formed the text-books of faculties and of the practitioners. As an instance of the high esteem in which Arabian authorities were held it may be stated that Louis XI in his reign was obliged to put up immensely valuable securities, besides other persons giving their additional personal guarantees, for a loan from one of the universities of France of a copy of Rhazes, which he wished transcribed for his own library. Avicenna was then the Koran of most of the faculties, who followed his precepts as if they had been of divine inspiration or as a supreme judge would follow the constitution. Averroes, Rhazes, Avicenna and all other Arabian authorities were then the only guides and law to all European medicine.

The horror aroused throughout intellectual Europe can therefore be better imagined than described when, in 1514, a Parisian physician, and a classical scholar of the first order, dared to raise his voice against the bleeding methods of the Arabians and in favor of the long-forgotten and almost unknown system of Hippocrates. Here was heresy raising its anarchistic head with a vengeance, and all faculties and repositories of the science of medicine were not slow to train their rhetorical guns upon this audacious disturber of the peace and quiet of the medical world. This revivalist of the bleeding practice of the early Greeks, and newly enlisted champion of Hippocrates, was Pierre Brissot, who after a careful study of the relative merits of the two methods had decided that the Oribasian practice was founded upon altogether too arbitrary and erroneous premises, as he could not conceive of a morbidity of the blood being viewed as insisted upon by the Arabians, as a purely local affection, which attacking any given organ was to be relieved by drawing away the blood as far as possible from the affected parts.

Brissot looked upon local diseases as being due to local congestions, and held that the best way to relieve the patient was to remove blood as near to the affected part as was possible. In those times epidemic diseases of a violent and malignant type were far more common than at present, and it happened

that in this year Paris and the neighboring villages were being visited by a deadly epidemic of pleurisy, an opportunity that Brissot at once grasped as one of the most favorable for the demonstration of the superiority of the Hippocratic methods of bleeding over that practised by the followers of the Arabians. For the purpose of furnishing a most convincing demonstration of the correctness of his views, he ordered his assistants to bleed gratuitously, according to his new method or rather the old method revived, all applicants during the prevalence of the epidemic. Such was the contrast in the nature of relief afforded to the afflicted, through Brissot's method of bleeding over the methods of his opponents that it encouraged Brissot to openly take the field in favor of the Hippocratic method, publicly proclaim its superiority, and to openly and bravely take issue with all the Oribasians, or followers of the Arabian method.

Brissot showed the inferiority that resided in attempting to delay or avert the great and sudden dangers that attended a violent onset of pleurisy, by the too slow, too distant, and insufficient procedure of bleeding from the feet, when only a rapid and full bleeding, so that the affected parts could be well drained of their blood, could be looked to for immediate relief, and that to accomplish this, it would be necessary to draw blood from as large a vein as possible, and that in the nearest neighborhood to the congested part. Whatever of fault there may have existed in Brissot's theories, his success over his opponents was so visible, that unprejudiced men began to come to his aid, and among them were to be found some of the best instructed of the Parisian physicians, two of whom, Villemore and Helin, were among the medical celebrities of the day; the conversion of the latter being more particularly noted from the fact that he had been so unfortunate as to lose his son from the epidemic while he was being bled in accordance with the Oribasian precepts. The success of Brissot, and the high character of the allies that he secured only served to inflame his obstinate and opinionated opponents to greater activity and malignity, and his plain and outspoken utter-

ances only added to their wrath; their attacks upon his reputation and character at last became so persistent and so annoying and disagreeably personal that he determined to leave Paris for a season and devote his time to travel, something which would afford him both a much needed rest and new opportunities for study and observation.

Leaving Paris, he journeyed southward, crossed Spain, and bent his steps towards Portugal, where, in the city of Ebora, he accidentally encountered a like epidemic of pleurisy as the one which he had just seen in Paris. The Portuguese physicians, like all those of the Iberian peninsula, were one and all staunch adherents of the Arabian methods of practice; their medical traditions, education, views and ideas, being all derived from their Saracenic conquerors who had established their medical schools. Many of these Iberian practitioners had not even ever heard of Hippocrates or of Galen, except through Arabian sources, and looked upon anything not contained in the works of the Arabians as being something most decidedly wrong, heretical, and in the light of some dangerous and experimental innovation. That which had been a storm of opposition in Paris to Brissot, turned out to be a veritable hurricane of indignation in Portugal and in Spain. One of these horror-stricken and outraged Portuguese physicians, a man of considerable note and standing, by the name of Denys, openly attacked Brissot and his Hippocratic views through a pamphlet. As was then the custom, this was immediately answered by Brissot in a counter-pamphlet termed "An Apology" for his system; this apology, being by the way, the only writing of Brissot's that survived him, and it was the perusal of this only production that induced the erudite and classical medical historian Sprengel to denominate Brissot a great philosopher, as well as a clear-sighted medical genius.

In our own times, with altered constitutions, more abstemious habits, more neuroses and a great deal less of plethora, with dissimilar diseases, different foods, and different people, we can form no idea of the needs of medical practice of those far-back pleth-

oric and highly choleric times, and therefore are in no condition to judge of the urgent needs of bleeding, which is so vividly represented in the clinical histories of the past centuries as being so necessary and accomplishing so much good, and it is only by following some of the arguments used on either side of the Brissotian controversy that we obtain glimpses of the theories and of the actual existing reason for some of the bleeding of the time, arguments that, given a like case at the present, would convince us that the judicious use of the lancet was the only safe remedy. "Take a case of metastatic pleurisy," would suggest the Oribasians, "one depending upon the suppression of the menses, and is it not then better to draw blood from the feet than from the arms?" There was no gainsaying, either by the Brissotians or even by us of some four centuries later date, that the Oribasians, intending to deplete the parts adjoining the organs in the pelvic region, could accomplish the desired end much better by bleeding from the legs or feet than from the arms or temples.

As observed by Sprengel, with all his erudition and philosophy, Brissot was liable at times to make out a stronger case for his side than could be carried out by strict adhesion to pure medical rationalism. For example, he advanced the theory of a specific morbidity of the blood in the neighborhood of the affected parts which the bleeding would tend to remove from the system if practised immediately on the diseased parts; whereas, that by bleeding at a distance, in accordance with the Arabian method, a great detriment was inflicted, as this acrid or morbid blood was not removed, but in its place was taken among the purer and normal blood dwelling in distant parts, which should rather be encouraged to remain.

It is questionable whether Brissot really believed this morbid blood theory himself; in fact, it would rather seem, that in following Denys in the foggy swamps and quagmires of his medical philosophy, he felt that he must use some form of argument easy of comprehension and to the taste of the Iberian form of medical reasoning, and to meet them on such grounds he adopted the illustration above described.

Both Brissot and his antagonist were, however, in complete ignorance of the real nature of the circulation of the blood, and from this ignorance came all, what to us is very plainly evident, the very illogical flounderings of the contestants which too often totally ignored that the blood circulated.

The controversy thus well defined, between Denys and Brissot, and brought down to concrete premises, spread thoughout Portugal and Spain, and the quarrel assumed a bitterness that had been unknown in France. Unfortunately for Brissot, unused to the more variable climates and sudden changes of the peninsula, he was seized with a dysentery which ended his life and labors, as well as his share in the controversy on bloodletting, in the year 1522, after 10 years of earnest crusading against the Saracenic methods of bleeding. As often happens, however, the cause that he had so ably and fearlessly championed in life, lost nothing of its momentum in his death. Adherents to his views, willing and ready to fill the vacancy caused by his demise, sprang up on all sides only to cause renewed vigor and more bitter counter-attacks from the Oribasians.

His views, which had been most substantially aided by the public knowledge of his successes in Paris and in Ebora in treating the pleurisy, with the publication of his "Apology" after his death, which placed his views in a concrete form, served to enlighten as well as to embolden his posthumous partisans to such a degree that they gathered recruits from the unprejudiced, uncommitted, and the broader-minded of the profession; even the celebrated University of Salamanca, with its array of hoary-headed doctors and professors, probably not unmindful of, or uninfluenced by, the ridiculous dilemma in which only some 28 years before they had placed themselves by laughing at the proposals of the geographer Columbus whom they had incautiously treated as an insane visionary; and now, not desirous to be left in another like ridiculous plight, determined to float with the rising tide, and horrified the conservative Spaniards by bodily going over to the Brissotians, thus deserting the traditional and time-honored venesection teaching of

the Arabians for the teaching and practice of Hippocrates.

This last serious defection in their ranks broke the spirits, patience and common sense of the remaining obstinate and blinded Oribasians, who, in their exasperation, looked upon the action of the Salamanca doctors and the University as being as traitorous as that of Count Julian when, in the reign of Roderick, he had sold and betrayed his native land and people to the Moors. The influential and authoritative position of the University was a power to the Brissotians, as it placed the Oribasians at the greatest disadvantage by leaving them without a bulwark, and in their dire extremity they appealed to Charles V to exercise his royal prerogative to proclaim the new practice heretical and abolish it in his domain, claiming that it was more dangerous to the welfare of humanity than the rebellion that Luther, of Germany, was then waging against the Holy Church was to the spiritual. The mutual relationships existing, in a sense, between the two heretical innovations, the one affecting religion and the other medicine, and the pressure brought to bear by the exasperated Oribasians upon the Emperor, undoubtedly would have carried the day against the new method of bleeding, and but for the timely assistance rendered to the Brissotians by a providential accident, an imperial decree prohibiting the exercise of the old Grecian or Hippocratic method of venesection would certainly have been obtained, a decree that would have exercised its power not only in Spain, but likewise in the Netherlands and in Germany, as well as in northern Italy. It has often been the saying of radical republicans, democrats and socialists, that princes serve no useful or earthly purpose. This accident, however, proves the fallacy of this social and too democratic view of the matter, as a prince, even a dead prince, here came to the aid of science and medical logic, and however unwilling he was to fill the position of witness or that of a prominent factor in this instance, he was there nevertheless, in strong and effective evidence, and assisted most materially in warding off the restraining dictum of the emperor.

This timely accident was nothing less than the death of the son of Charles III, the then reigning Duke of Savoy, who was on a visit to the court of Charles V, at the Spanish capital. The epidemic of pleurisy that had devastated the neighborhood of Paris, and which had been the cause of the beginning of the controversy in Portugal and Spain, still lingered fitfully, here and there, to harvest its sporadic victims, and in its severe democracy being no respecter of persons, and knowing no difference between plebeian and royal blood, it attacked the august person of the unfortunate prince, who would have been far better off, eating chestnuts and goats'-milk cheese, in the semirustic but healthy court of his ancestors among the bleak mountains of Savoy, than shining at the Spanish court. This is, however, neither here nor there, and here was the unlucky Savoyard princeling prostrated by the deadly pleurisy, and gasping for breath, with a suffused eye and an apoplectic chest, and very miserable,—just as much so as if he had only been a marmot-dancing Savoyard rustic.

The court physicians were of the old orthodox stock, and no sooner was the prince in the full grip of the pleurisy, than these worthies proceeded without further ado to bleed his royal highness from the feet in the most approved Arabian fashion. The poor prince, however, was destined never to revisit his beloved Savoy, but was ordained by a wise Providence to serve as a principal and determining factor in the great bloodletting controversy, which was then as yet only in its infancy, and in accordance with these decrees the efforts of the Oribasians were of no avail, and the prince soon after was no more. This taking off of a robust prince, right in the flower of his manly youth, and he coming from an ancestry whose progeny even at the present is proverbial for its physical stamina and great resistance to wear and tear, was a serious blow to the cause of the defenders of the Arabian method of bloodletting, and this, too, just at a time when the latter were importuning the emperor to suppress their rivals by a sweeping royal decree. This unfortunate event set the emperor

thinking, and the result was that he allowed the controversy to proceed without his royal interference, depending upon that evolutionary process which generally presides over the election of the survival of the fittest to work out its own solution of the difficulty.

In the old classic abode of Hippocratic and Galenic medicine, Italy, where the old form of bleeding had for some time given place to the Arabian methods, the latter having been introduced into the country through the Saracenic and Jewish physicians in the school of Salerno, the opposition to the reestablishment of the older practice was fully as stubborn as that experienced by the Brissotians in France and in Spain. As soon as the first copies of Brissot's now celebrated *Apologetica Disceptatio de Vena Secanda in Pleuritide* arrived into Italy, his views were fiercely attacked by Andrea Thurinus, of Brescia, who then occupied the very influential and authoritative position of chief physician to his Holiness the Pope, Clement VII. Thurinus, in accordance with the humoral ideas of the time, assumed that at the inception of a pleuritic attack, the morbid humors had as yet only feebly invaded the affected parts, and that, consequently, the methods of the Oribasians of bleeding from the more distant parts would tend to divert these same morbid humors from invading and overwhelming the already weakened and weakening tissues. Hippocrates had not mentioned anything concerning such views, but Thurinus, in common with the many followers of Oribasius, now undertook to explain this silence on the part of the Father of Medicine, by making the latter adopt his views, claiming that if Hippocrates was rightly studied, various texts would be found, which would suggest that he counseled this distant form of bleeding, even if he did not expressly mention it.

Sprengel tells us that the next defender of the Arabian method to enter the lists was Luigi Panizza, of Mantua, who labored hard to produce a defence which Sprengel terms as being something "execrable in style, and so barbarous in its intent and conception as an attempted logical dissertation, that it wearied the

brains of those who undertook to unravel or to comprehend his methods of reasoning." Being possessed, in common with all men of his class, with the most indefinite and rambling notions concerning the existence, etiology, and pathology of the morbid humors, and utterly at sea as to any information of the existence, objects, courses, or play of the circulation in the economy, he reasoned from a bewildering and barbarous mixture of geometrical and astrological premises, arguing that it was best to bleed from a distant part or vein, as, for the first 8 days of a disease, the determination of the mass of blood towards the affected parts would necessarily be inconsiderable, therefore he advised that for this primary period of invasion it was best to follow the Arabian system of bleeding; after which, if the disease still persisted, blood might then be drawn from a nearer vein according to the Hippocratic or Greek system. When we consider the paludal nature of the country in which the mathematic and geometric Panizza practised his skill, the great heat in the valleys at noon and the nearness of the mountains which at times suddenly and unexpectedly pour down the most chilling of blasts, inducing all manner of fever and of acute congestive attacks either of the thoracic or abdominal organs, we feel that either the inhabitants or Panizza must have gone early, as he must, if he lived long enough, have been a most deadly practitioner, and unless Providence took him off in time, it is safe to say that he would have depopulated the country just as he horrified all logical minds by his barbarous dissertations.

The sixteenth century stands unequalled for the quantity, intensity, and varied as well as the opposite quality of the mental activity that upheaved Europe. A grand high carnival of intellectual progress then raced alongside the most benighted, obstructive, and self-asserting stupidity, ignorance, superstition, and insanity. At times, these were all coexisting conditions in the one individual, and great intelligence in any one line of thought did not prevent the exhibition of the most narrowminded stupidity in another line, nor did a broadminded conduct in some regards always exist unsullied by the most vicious and contemptible

exhibition of narrowmindedness in others. But few men were then able to maintain a level-headedness, or a generous order of intelligence. All mental attributes were then greatly exaggerated, and genius and insanity exhibited an alliance and an activity that has not been seen or experienced since. It was a period of fierce disputes, unrelenting hatreds, blind bigotry, persecutions, and of the greatest general developments of that enthusiasm that begets the martyr, and a most unsafe period for the existence of men of advanced ideas, and of clear sight, and a fearless and unselfish singleness of purpose.

The Council of Geneva at this period and at the instigation of Calvin burned poor Michael Servetus at the stake; the secular power of Rome, at the instigation of the church and papal power, burned Giordano Bruno at the stake in Rome, and the Parliament of Toulouse burned poor Lucilio Vanini at the stake in Toulouse, all for their being clear-sighted and of a more inquiring mind as well as more fearlessly outspoken than their fellow-men. Two of these martyrs, Servetus and Vanini, had studied medicine, all had studied philosophy, all had studied theology, and Bruno and Vanini had taken holy orders. One was a Spaniard and the others were Italians. But for the habit of the times that based all things on theological philosophy, one of these three progressive and probing minds might have at once solved the great question that was then rending the medical world, as he had already partly removed the veil that hid from view the mysteries of the circulation of the blood; his early theological education and a love of polemics, with serious antitrinitarian views, led him into the cruel power of Calvin and to the martyr's stake, and medicine lost a great thinker and a restless investigator. Could Servetus have confined his mind and studies to medicine, and left theology to the priesthood, medicine would have been the gainer, and the Brissotian controversy possibly cut short. He had already discovered the lesser circulation and this would have soon led him to the discovery of the greater.

Servetus unwillingly and unenthusiastically went to the stake and with him perished what progress he

had made in medicine and towards discovering the circulation of the blood, and the disputative proclivities of the times and the attending ignorance upon the subject hid in the controversy of which Servetus had had only a glimpse, only increased the fury of the fray, as there is nothing that most men will so persistently and furiously argue about as that of which they know but little or nothing. All the Italian university towns hastened to pour out their contingent to the theoretical defence of the Arabian system of bleeding, as if again sending forth their armies to repulse a Brennus, an Alaric or an Attila; Padua, Venice, Bologna and Naples contributed to the general defensive assault provoked by the antagonistic presence of the "Apologia" of Brissot in Italy, and they one and all fell into the same train of reasoning advanced by the reckless and illogical Panizza. In Naples, Donato Antonio d'Altomari arose in opposition to the doctrines of the departed Parisian, although his erudition and intelligence made him admit the full justice of the Hippocratic practice of bleeding in cases of plethora, a practice which he was frank to admit, he always followed, advising, however, in all delicate constitutions, a preferable adherence to the Oribasian system.

Sprengel tells us that a Seville physician, Nicolas Monardes, advised bleeding from the saphenous vein in metastatic cases of pleurisy due to suppression of any periodic discharge; in cases of pleurisy due to great sanguine plethora he advised bleeding from a vein in the arm opposite to the affected side. Monardes was a firm believer in the dangers that arise from drawing the humors to the affected side, and entered into the dispute with considerable spirit, contributing in 1539 to the controversial literature of the period, a dissertation entitled "*De secanda vena in pleuritide inter Grecos et Arabes concordia.*"

In the year 1564 there swept over Switzerland a wave of malignant pleurisy, with one of those attending results, in a medical sense, that often cause erroneous conclusions. Many of the medical men of that period were too apt to judge superficially and draw wrong conclusions, just as some of their more

modern brethren and the laity are at the present, who will often attribute cures to the most impossible of therapeutic measures, through want of sufficient knowledge, appreciation, or analytical power of observation. As remarked by Sprengel, in the beginning of the epidemic, when the greatest fatalities naturally occurred, the bleeding employed was in accordance with the Greek system, while at the decline of the epidemic, when its virulence had been spent, the Swiss practitioners, discouraged at their want of success, returned to the Arabian method. Without considering the law of fluctuations in the intensity of pathologic activity that governs most epidemics, which may be often likened to the sweep of the force of a storm in its passage, first tearing up and uprooting all delicate plants and sweeping everything before it with resistless force, then gradually subsiding, probably to renew its blasts with increasing force, the fatalities and recoveries were indiscriminately accorded to the different methods in bleeding, instead of to the varying intensity of the epidemic, and as the Arabian system was adopted at the decline, when the most susceptible and easily affected, and therefore the ones most likely to succumb, had been eliminated from those likely to become affected, and, as has been said, the epidemic had spent its force, the episode served as a rallying point for the disheartened defenders of the Arabian method, who, gathering fresh courage from the event, renewed the battle with greater acrimony and fierceness.

In the end, the controversy brought about those concrete results that nothing else could so well have stimulated into existence, as observed by the erudite Dunglison, when referring to this long war: "We need not dwell on the disputes relative to the proper place for the bleeding according to the nature or seat of the disease. These controversies respecting revulsion and derivation which went on during the whole course of the sixteenth century, and in which each party speculated according to the humoral notions of the time in vogue, could not fail to retard the progress of the art. The discussions, however, excited the researches of the anatomists, researches that were not

without their use in the subsequent discovery of the circulation of the blood." Heretofore, the discussions had been carried on on purely theoretic and speculative grounds, but from now on came the turning point in the controversy, and the original disputes of Brissot and Denys were entirely lost to sight, the anatomist taking the place of the theorist and seeking in the body for a material solution of the subject.

Among the most celebrated names connected with this stage of the controversy is that of Andreas Vesalius, the anatomist, who first traced the course of the azygos veins and their connection with the lower intercostal veins, thus forming the connecting link with the original subject in dispute. No sooner was the discovery of Vesalius made public than a new element entered into the dispute, as the staunch adherents of the humoral theory, who professed to be guided by the anatomic relation of the parts, now laid the greatest stress upon the necessity of strictly locating the exact limits occupied by the pleurisy, as they pretended that this must altogether elect the locality for bleeding. The right axillary vein now became the choice locality for drawing blood in cases of pleurisy, as, according to the new dispensation, this vein was the nearest channel existing between the azygos veins and the venae cavae.

Following in the steps of Vesalius, Amatus Lusitanus, a professor of Ferrara, pushed his investigation into the structure of the veins whose courses and connections had been so well studied by Vesalius, and the result of his researches somewhat upset the new theory concerning the new location of bleeding in pleurisy by the discovery that these azygos veins were furnished with valves. This was a signal for violent hostilities in a new quarter, as Vesalius ungenerously attacked the assertion of Lusitanus, and, treating the latter as a visionary and presumptuous lunatic, denied the existence of any valves. Vesalius being assisted in his attack by Thaddeus Dunus, an Italian physician of Lucarno, who was just then rusticating in the mountainous air of Switzerland for his health and incidentally to keep out of the way of the Holy Inquisition whom he had offended

by proclaiming various heretical opinions. Fallopius, the anatomist, then teaching anatomy in Venice, as well as the equally celebrated teacher Eustacius, and Vallesius, all held up poor Lusitanus to ridicule for making, as they said, such utterly unfounded and idiotic assertions. Thirty years afterwards, however, Fabricius de Aquapendente reaffirmed the discovery of Lusitanus, and quietly arrogated to himself all the honor and credit of the discovery. The name and authority of Fabricius were too all powerful to be set aside, and Vesalius and Dunus soon found themselves alone in their antivalve opinion, and bleeding from the axillary veins was at once abandoned, as it was very evident from the demonstrations made by Fabricius (which in no way differed from those made priorly by Lusitanus) that bleeding from the axillary vein did not directly draw blood from the pleura.

The controversy, originally inaugurated in Paris by Brissot, thence carried into Portugal and Spain, was confined to the discussion as to the superiority of the Hippocratic over the Oribasian method of bleeding, pleurisy being the particular disease which first called the question into existence and over which the battle had been waged. With the advent of the anatomists into the field, the disputes of Brissot and the Portuguese Denys fell into oblivion, the battle then raging between the rival anatomists, the relative merits and functions of their discoveries, and their adherents. In the meantime the Greek had gradually supplanted the Arabian method of bleeding. The impetus, however, given to anatomic studies was such that it did not stop until Harvey made his great and important discovery.

Having more than once referred to the very pleasant and cordial if not over lively and too interested relations that existed in those bustling times between physicians and the Catholic as well as the Reformed Churches, it will not be uninteresting to note how extremely agreeable and happy life was made by the Church for some of the personages mentioned in the course of this narrative. We have already seen the kindhearted and pious reformer Calvin burning

one of our fraternity at the stake for a slight difference of opinion existing between them concerning the dogma of the Holy Trinity, while we have seen the Church instigate the Toulousean Parliament to burn another of our confrères for some equally as trivial matter. Andreas Vesalius came near being a victim for *auto da fé* in Madrid, and only escaped through the determined interposition of his patron, Philip II, to whose person he was attached as a medical attendant. It appears that a Spanish gentleman, supposed to be dead, was a little too previously made the subject of what was intended for a postmortem examination by Vesalius, whose too great and enterprising zeal as an original investigator proved fatal to the cavalier, but which, instead of a postmortem, turned out to be, as in the case of the amiable and spiritual Abbé Prevost, the author of Manon Lescaut, a sort of antemortem examination, or rather, a sort of a scientific medical execution, such as some of our faculty in New York were lately charged with performing upon a noted but cataleptically inclined and too convivial mind-reader. The Inquisition, which just then managed all secular as well as religious matters for Spain, at once took cognizance of the unfortunate medical *faux pas* by laying its heavy hand upon the anatomist, whom it certainly would have sent to the stake to expiate his impiety for thus attempting to forestall the decrees of Providence, but for the undisputable exercise of the royal prerogative of Philip.

As it was, Vesalius did not altogether escape punishment nor did he in the end escape death for the deed, as he was only allowed to escape the sentence of the Inquisition on a compromise, which ordered him to perform extreme penance by undertaking a pilgrimage to Jerusalem. Vesalius promised to perform the ordered penance and the pilgrimage upon which he at once set out, but on his return from the Holy Land by sea, he was overtaken by a storm and shipwrecked on the coast of Zante, where he died in 1564 at the early age of 40 years. There are no doubts but that hearing of this catastrophe the Holy Inquisitors must have reproached their own con-

sciences for having let him escape the stake, as Providence certainly pointed to their backsliding by taking the matter into its own hands and thus vicariously executing the unlucky Vesalius.

Another of our enterprising anatomists, Amatus Lusitanus—like to his namesake Zacutus Lusitanus, also a physician of note, who escaped the clutches of the Inquisition and an *auto da fe* by a most hasty and precipitate flight from Lisbon—also had *his* experience with the Holy Brotherhood and the Holy Inquisition, and only managed to escape the dungeon, torture chamber and final burning, by hastily decamping from one place to another, being finally able, like to Voltaire's beautiful but erratic creation, the optimistic professor, Panglos, to put to sea, on which he sailed and sailed, until he reached the safer coast of Thessalonica, where he lived in poverty and want but in peace, and finally enjoyed the extreme felicity of dying a natural death—an ending that not all were allowed to enjoy in those grand old days of struggle of mind with mind, and of heresy and orthodoxy.

Restless and combative Thaddeus Dunus, who recklessly wandered into the mire of contention prepared for him by the discovery of the azygos veins and their course by Vesalius, and who was finally left stranded by the adoption of Lusitanus' discovery of valves by Fabricius, fled, as we have seen, from the uncongenial theologic atmosphere of Italy, leaving behind him a reputation as a physician, along with the sorrows of the disappointed Familiars of the Holy Inquisition, who were most anxious to lay hands on this too free-minded and free-thinking physician and convert him from his heretical notions to the true ways to the spiritual salvation, even if they should have to burn him at the stake. In the free air of Switzerland he managed to live to the ripe old age of 90; a good old age for an irascible temperament to reach, and an age that he never would have attained if the Inquisition could have laid its hand on him. From the experience of these men, we most conclude that the prosecution of medical studies which were at times liable to bring one in conflict with the prevaling theologic ideas of the period, was an oc-

cupation not devoid of danger. Our own times are much the safest for science as well as for theology.

Prior to the demonstration of Harvey the medical world had existed in the most complete ignorance of the nature and existence of the circulation. That this ignorance existed even during the time that Harvey was lecturing upon his still unfinished work before the medical classes of London is very evident from the opposition that his views met, when several years after these lectures the perfection of his work permitted of its public announcement. Even the general run of the medical professors in the universities were unprepared for its acceptance, and strange as it may seem among these were even some of the most celebrated anatomists of his time.

The unbelief and incredulity in the great discovery was, however, mostly confined to France, to the north of the Rhine, and in England to the solitary instance of Primrose. The latter was a graduate of Montpellier, Paris, and of Oxford, and enjoyed a great reputation in Yorkshire, where he was permanently established. His parents were Scotch, his father being a dissenting clergyman, from whom he inherited that peculiar unreasoning controversial spirit that led him to refuse to even consider the possibility of Harvey being correct in his deductions. With unpardonable stubbornness for a man of his great abilities and learning, he denied the existence of the circulation and even that of the chyliferous vessels. In 1630 he published a labored dissertation refuting Harvey's views, "*adversus Gul. Harveum.*" Poor Primrose was so set in his opinions—however or whenever formed—that he never forgave his former and very good friend Plemp, a graduate of Bologna and a professor of medicine in the university of Louvain—Vopiscus Fortunatus Plempius was this worthy professor's academic or scientific name—for having adopted Harvey's views after having first denounced them. All these oppositions only cause to stand out in much bolder relief the genius of Harvey, who possessed the rare patience, endurance and skill while under the fire of the continent to systematically and quietly follow in the insect, the bird, and the mammal akin to his own species, as

well as in man, the studies required to elucidate the mysteries of the circulation from embryotic life to the adult age, thus firmly establishing the foundations for his great discovery.

It seems almost incomprehensible how Hippocrates and Galen could have written so clearly on medicine and diseases and still have remained ignorant in every sense of the existence of the circulation of the blood. When we read Aretaeus, we are still more surprised, as he was both a practical physician and surgeon as well as a most courageous and enterprising phlebotomist and recognized that many seemingly and apparently purely medical ailments required a surgical interference. The great Aristotle with all his great store of philosophical and medical knowledge wandered about in the greatest obscurity when it came to discuss the office of the heart, as he knew absolutely nothing of the circulation of the blood. He imagined the heart to be the source of the blood; the vital fluid passed from the heart to the veins and that was the end of the blood. Galen, however, knew from experience and observation that the arteries contained or carried the blood, but looked upon the liver as the source of the veins. Michael Servetus is the man that we first meet that had any cognizance of a circulatory system. Servetus had observed the route of the lesser pulmonary circulation, but had not gone so far even in that, to realize that the whole mass of blood traversed the lungs. As we have seen, his antitrinitarian ideas coming into contact with the narrowminded and uncharitable John Calvin, put an end to any more investigations in anatomy or physiology on the part of Servetus.

The next name in order, connected with the discovery of the circulation of the blood, is that of a pupil of Vesalius, Realdo Colombo, a native of Cremona, a celebrated Italian anatomist, who successively filled the chairs of logic and surgery in the university of Padua, and in 1544 occupied the anatomical chair made vacant by Vesalius. It was Colombo who had the honor of performing the autopsy on the body of St. Ignatius Loyola, the founder of the Order of the Society of Jesus, Colombo being then a professor in

the university of Rome, where the saint died in 1556. This great anatomist, besides being a studious dissector, was likewise an indefatigable vivisectionist, performing these later experiments on the lower animals. It was from these vivisectionist observations that he learned of the nature of the pulmonary circulation in an exact manner, which enabled him to define that circulation in a clearer manner than had been done by Servetus, and from these observations he foresaw the greater circulation. Colombo died in 1577, leaving the great work unfinished; he had, however, discovered this much more than Servetus, that the mass of the blood traversed the lungs.

The discovery of the circulation next claims the name of Andrea Cesalpino, a great student and physician, born in Tuscany in 1519. Botany and the vegetable materia medica were his specialties. His philosophical opinions raised him some very energetic enemies in England and in France. Samuel Parker, archdeacon of Canterbury, and Nicholas Taurel, of Montbeliard, tried hard to bring charges of heresy against him, but these were not noticed in Italy, where he lived respected until his death in 1603. Some time before his death he was physician to his Holiness Clement VIII, from which we may infer that Cesalpino was looked upon as one of the faithful, in full communion with Mother Church, and in full odor of sanctity. If any one can, in a slight measure, contend with Harvey for the honor of the discovery of the circulation, it is without a doubt this patient and plodding philosophical Italian physician; and Bayle, of Toulouse, a contemporary of Harvey, does not hesitate to give the priority of the germ of the discovery to Andrea Cesalpino. Cesalpino wrote many works on medical subjects, and in the second chapter of the first book of his work "On Plants," occurs the following passage:

"*Nam in animalibus videmus alimentus per venas duci ad cor tanquam ad officinam caloris insiti, et adepta inibi ultima perfectione, per arterias in universum corpus distribui agente spiritu, qui ex eodem alimento in corde gignitur.*" This work was first published in 1583 in Florence.

Whatever Servetus, Colombo and Cesalpino may

have known or done concerning the circulation, the honor of the ultimate prosecution of the dissections that finally permitted of its clear demonstration most certainly belongs to Harvey, who labored long and faithfully to accomplish his task. Haller, the great physiologist, seems to doubt whether Cesalpino understood more than the course of the lesser circulation as demonstrated by Colombo, while Lerminier believes that while he describes the pulmonary circulation in the most precise manner, that his writings tell us quite plainly that he had also an acquaintance with the greater circulation,although he was restrained from really asserting the fact, owing to his want of precise knowledge concerning all its details, as there are no doubts but that he was in utter obscurity concerning the abdominal venous circulation. All these were left for Harvey to discover and to demonstrate, who seems to have wisely refrained from making any general announcement until he had completely mastered the whole subject. That Harvey had foundations whereon to build is undisputable, but the clearness with which he saw all which, up to his time, had been unseen, and the clearness of his demonstrations of the subject entitles him to all the credit and honor of the discovery.

In looking over Harvey's dissertations in support of his views concerning the course of the circulation, we see ample evidences that the discoveries of Amatus Lusitanus, elaborated on and extended by Harvey's anatomic master, Fabricius d'Aquapendente, were the primary incentive or causes that guided or urged him on, as it is the presence of the valves intended to prevent any retrograde movement in the blood-current and like fingerposts pointing out the direction in which the blood must flow, that forms his first supportive proofs or reasons for the existence of a continuously moving current or stream. It was the patient and laborious following up of this thread that enabled him to follow the course of the current. As Voltaire would say, this was all due to the application plain and simple of the system of Zadig.

We have now arrived at the period of the real and complete discovery that was to revolutionize all ideas

concerning medicine. Prior to this, as we have seen, all was theory and speculation, unfounded assertions and denials, and all controversies were carried on in the thickest of mists and in the greatest obscurity as to premise, and consequently with the greatest acrimony and without tangible or beneficial results. With Harvey and the final acceptance of his views a new era of civilization and of concrete thought opened up for medicine.

William Harvey was born in Folkstone, in the county of Kent, England, on April 2, 1578, in the period when the great bleeding controversy was at white heat, and consequently entered into his student career while all anatomists and physiologists were still in and busily engaged in searching in the body for a solution to the many questions raised by the Brissotian war. The oldest of a family of 9 children, of whom 6 were boys, he alone chose the laborious and unremunerative life of a scientist, his 5 brothers embarking in commercial enterprises and all becoming successful and wealthy merchants. Beginning his studies in England, he soon crossed over to the continent to avail himself of the greater advantages offered by the schools of Germany and France, finally reaching Padua in Italy, where he entered the university, becoming a pupil of the famous Fabricius d'Aquapendente, the enterprising anatomist whom we have seen coolly appropriating all the discoveries and honors due to Amatus Lusitanus concerning the existence of valves in the azygos veins.

Harvey remained in the University of Padua five years, receiving his degree or bonnet of doctor of medicine in 1602. It was undoubtedly in the venerable University of Padua, under the spur imparted by the researches of the enthusiastic and indefatigable Fabricius, and where still there lingered the memory of the work of Colombo, with the books of Colombo, with the books of Cesalpino and of Savonarola on its library shelves, while the great anatomists were all busily searching for new anatomic truths, that Harvey imbibed that love for anatomic studies and dissections, and especially those of the circulation, that eventually led him to complete that for which Vesa-

lius, Lusitanus, Servetus, Colombo, and Cesalpino had so persistently sought or so dimly imagined.

On his return to England he entered Cambridge and a second time received the degree of doctor. Fixing upon London as his residence in 1604 he soon acquired a reputation, and in 1613 he received the appointment of professor of medicine and surgery in the College of Medicine in London. He was successively the physician of James I and of Charles I, and if his predecessor Colombo had the felicity of dissecting and examining the body of Saint Ignatius Loyola, Harvey had the greater felicity of dissecting and looking into the anatomy of "Old Man Parr," who had at the invitation of the King, visited the royal court, the unwonted feasting at that court and the too sudden and unused gourmandizing at the solicitation of the courtiers, who could conceive no other entertainment for the old man but to gorge him, thus putting an end to his many days at the advanced age of 153 years. It is worthy of note that Harvey found all his organs in perfect state of health and no pathologic changes in any organ to account for his death, even at an advanced age.

We may judge of the care, labor and patience that characterized Harvey when he expended nine full years in elaborating and perfecting his knowledge of the circulation after he had mastered its main details and lectured upon them to his anatomic and surgical classes. Like Realdo Colombo, he devoted much time to experimental anatomic study on animals, and it was in this field that he undoubtedly made the greatest progress towards his final discovery. Charles I, who greatly loved Harvey, and who as a man possessed the greatest admiration for his talents as a scientist, became greatly interested in his labors, placing even the animals of his regal park at his disposal. The fine portrait of Harvey, demonstrating the course of the circulation to his royal friend and patron, upon one of the stags of the royal park, shows in what intimacy the two men must have lived, and to what extent Charles sympathized with him in these pursuits.

Besides the unfortunate King, whom Harvey loyally

followed to the field and in his misfortune, this great physician enjoyed the friendship of the greatest philosopher then in England, this kindred spirit being Sir Christopher Wren, the great architect, who was also an astronomer and a scientist. Wren entered into the labors and researches of his friend with all the warmth of a student's nature, and assisted him in every possible manner. These two untheoretic but extremely material and practical spirits were the first to conceive the idea of the possible utility of blood-transfusion in connection with the newly discovered route of the circulation.

Harvey was probably one of the most modest men that ever graced the British profession. He was a close student, and one of the most logical of minds. After the first public announcement of the circulation, his views were attacked by some of the most eminent men of the continent, among these being Vauderlinden, P. J. Hartmann, Hoffman, Dislincourt, Charles the son of the celerated Guy Patin; and the greatest French anatomist of his day, John or Jean Riolan, the son of the dean of the Parisian faculty of medicine. Harvey was not in the least disturbed by all these attacks. From his many opponents he only chose to answer one, this being Jean Riolan, whom he completely put to rout by his exhibition of his views in the "*Exercitationes duae anatomicae circulatione sanguinias at Joan Riolan filium*," which was published in Rotterdam in 1649. All that was left to his envious detractors was to vainly attempt to prove that the system of the circulation was known to the ancients, a proposition perfectly untenable as the writings of all the great masters from Hippocrates down through Erasitratus, Herophilus, to Galen, and to that great Aretaeus of Cappadocia (whom Hartshorne terms the ancient reflection of our Sydenham and Laennec in empirical science) there is not a word that would imply or even suggest any such acquaintance.

Harvey lived modestly and philosophically throughout the depression that overcame him with the fall of the Stuarts, and through his various honors and successes always remained unchanged. Calamities or honors were alike undisturbing elements to this heroic soul. He died at a good old age in 1658.

On a retrospective glance, running backwards into the dim past and peering into the ancient schools of Cos and of Cnidus, we are struck with the fact that the old adage of Cicero, "*Praestat naturae voce doceri quam ingenio suo sapere*," which was the spirit of Hippocrates for many ages before Cicero formulated it into a phrase, and was the guide of Galen, Serapion, and of the leading Arabian physicians, seems to have steered those wonderful minds past many a reef that has wrecked some of the more modern followers who have allowed themselves to be led more into theoretic than natural teachings to direct their course and who may be said to be the modern representatives of the old Cnidian school.

The ignorance of our medical brothers of the fifteenth and sixteenth centuries is not so much a matter of surprise or astonishment, as one need but look at the Chinese, with their very ancient civilization, who now possess no more rational ideas concerning the scheme of the circulation than was possessed by the ignorant opponents of Brissot, and who even lack the spirit of inquiry and of advancement requisite to adopt from others that which has been known and well demonstrated. And yet, with the most sublime ignorance of the circulation, they make more of the pulse than is made by Europeans or Americans, giving to each organ its particular pulse, besides having seven external pulses depending on heat, and eight internal pulses to denote the quality, etc., of the radical humors, with nine final pulses which tell them of the condition of the ways of communication between the important parts of the body; and with the further drawback for the Chinese, that a celestial Brissot, who is to initiate the movement for their medical emancipation from the ties of tradition, ignorance and superstition, is an utter impossible creation.